SCIENCE.

FRIDAY, MARCH 6, 1885.

COMMENT AND CRITICISM.

The increased favor with which the orogenic theory of earthquakes — the theory that regards earthquakes as the effect of disturbances due to mountain growth — has been looked upon in recent years must be accounted a distinct gain for physical geology. The volcanic theory, now rationally limited, has long been more popular. It is not long since Mallet, who has been widely quoted as an authority on the question, committed himself to the narrow statement that "an earthquake in a non-volcanic region may, in fact, be viewed as an uncompleted effort to establish a volcano," although he afterwards held a broader opinion. Lyell wrote in the last edition of his 'Principles' (1876), very much as in his first (1830), that "the principal causes of the volcano and the earthquake are to a great extent the same, and connected with the development of heat and chemical action at various depths in the interior of the globe." More lately, Daubrée maintains a similar view, even after referring to the suggestions of Dana, Suess, and Heim, and concludes that "earthquakes seem to be like stifled eruptions which do not find an outlet, about as Dolomieu thought."

One of the chief reasons for exaggerating the value of the volcanic to the neglect of the orogenic theory has been the improper reading of earthquake maps. The map constructed by Mallet in 1858, still the best of its kind, is very commonly quoted as showing a general agreement in the distribution of volcanoes and earthquakes; but it is quite unwarrantable to include the well-shaken regions of Spain or the Alps, for example, in the volcanic district of the Mediterranean. The shocks of demonstrably volcanic origin seldom extend far from their centres: the eruptions of Italy do not disturb the adjacent countries. In the Alps themselves there is now no volcanic action whatever, nor has there been any of significant extent at any time in their geological history, so far as it is known. It is altogether gratuitous to suppose that the frequent tremors felt there result from concealed volcanic explosions; for they find sufficient explanation in the forces that have made the mountains, which are undoubtedly still growing.

Another cause for the former neglect of the orogenic theory was the almost universal belief that mountain ranges had been lifted up or burst out by expansive force from beneath, instead of squeezed and crushed together by lateral compression, as is now widely accepted. The difference has been concisely expressed by Stur of Vienna: formerly it was 'gebirgshub;' now it is 'gebirgsschub.' Of course, as long as geologists were generally of the mind that mountains were produced by uplift from beneath, it was natural to associate surface shocks with smothered volcanic action, whether eruptions followed or not; but, with the disappearance of the idea of uplift as applied to mountain ranges, it is as natural to refer earth-tremors in non-volcanic mountain regions to the crushing forces that produce the disordered mountain structure. There is, indeed, now sometimes seen a disposition to go, perhaps, too far in this reaction, and exclude volcanic action from nearly all share in causing earthquakes. Some of the English observers in Japan, a volcanic region *par excellence*, are of this mind, and attribute the numerous small shocks, even there, to structural and not to volcanic disturbance. It is a difficult matter to decide. Indeed, the study of earthquakes must, in great part, long remain in a two-thirds condition. Observations are plentiful, hypotheses have never been lacking; but verification can hardly ever be attained.

The lack of final and convincing verification

of hypothetical views has, however, not prevented attempts at the prediction of earthquakes, and the earthquake prophet must have his mention. Falb, an Austrian, figured in this *rôle* some years ago with such apparent success as to inspire an Italian admirer to compose a sonnet beginning

'O uom, che non puoi tu?'

More recently, Capt. Delaunay of the French marine artillery, and evidently a very different man from the eminent mathematician of the same name, made something of a stir by his predictions. In spite of severe criticisms from Faye and Daubrée, he persisted in maintaining that the Krakatoa outburst resulted from the conjunction of Jupiter and the swarm of August meteors, as he had foreseen it would. Worse than this, he announces a more violent 'seismic tempest' in 1886.3, when the malevolent Saturn lends a hand; and colonists in Java are reported to be troubled thereby! Another method of forecasting is discovered by Mr. Charles Zenger, who finds that electric and magnetic storms, aurorae, tempests, earthquakes, and volcanic eruptions, — all, simply enough, result from a single cause, whose cycle agrees with a semi-rotation of the sun. Nothing of this would be worthy of mention, had it not soberly appeared in the *Comptes rendus* of the French academy of sciences, where it is airily entered under the heading of 'meteorology.'.

A bill is to be introduced into the legislature of Massachusetts to regulate the practice of medicine. It is framed closely upon those already in force in several states in the union, such as Illinois, West Virginia, Alabama, North Carolina (Ohio, Maine, Pennsylvania, and Texas have bills under consideration), and provides for a board of medical examiners who shall not be connected with any medical school. They are to be appointed by the governor, and their function will be to issue licenses to practise medicine or dentistry, on the basis of a diploma from some legally organized medical college, or of ten years' practice, or of an examination of an elementary and practical character in anatomy, surgery, chemistry, pathology, obstetrics, and dentistry. After July, 1886, *all* candidates are to be examined. This board is to be endowed with legal powers sufficient to carry out the purposes of this act.

It will be noticed that this bill is not framed in the interests of any so-called 'school' or 'pathy,' and contains no allusion, direct or indirect, to points in dispute between such schools. The necessity of some such bill in the interests, not of medical science, but of ordinary decency and humanity, is probably hardly appreciated by more than a small fraction of the community, even of the more intelligent portions. One often hears expressions used implying that the user supposes that a diploma confers the right to practise medicine, while the fact is that nothing of the sort is necessary. The privilege of giving (or selling) medical advice to one's neighbor is regarded by the state of Massachusetts as one of the most fundamental and inalienable of rights, and on a par with "the right to life, liberty, and the pursuit of happiness." The only medical function for which this state legally demands even the pretence of a medical education is the signing of certificates of insanity. The practice of medicine, surgery, and obstetrics, with the right to sign certificates of death, may be legally assumed by any horse-car driver who some cold day feels that his profession demands too much personal exposure, steps from his platform, puts up his sign with an 'M.D.,' and waits for patients. If he publicly calls himself a doctor, he is legally one; and, if he escapes a suit for malpractice, the law cannot touch him.

This bill can hardly be objected to as too strict by any physicians, except of the class just described, or those immediately above it, or, on the other hand, by that portion of the community drawn from all social ranks who consider education as a positive drawback, and medical knowledge as a heaven-born inspiration. Most persons, however, who patronize

this class of practitioners do so out of pure ignorance, and they have a right to ask that the law shall give them some protection against too gross imposition. Those who object that this bill imposes the very minimum of qualification (and any who know how brief a study and how limited knowledge a diploma from a 'legally qualified medical college' may testify to, will be very apt to make this criticism) may be reminded that beginnings must be small; that the public is not yet educated in this intelligent state of Massachusetts to believe that the ignorant patients are entitled to any protection, or that the ignorant doctors are not entitled to the same recognition as any other business-man pursuing his calling under the disadvantages of the lack of early education.

It will be noticed that after 1886 the board will examine *all* applicants; and, although it cannot purify as much as might be desirable the present body medical, yet it can then guard the gates against future intrusions of ignoramuses. The strength of different 'schools' of medicine will undoubtedly compel some distasteful associations upon the board of examiners; but the importance of the interests to be served ought to stifle jealousies, and override etiquette. Purification of the profession can but tend to its unification and to the development of the truth. If we can be assured of a competent knowledge of the fundamental medical sciences in all who undertake to practise it, mere 'pathies' and fads must inevitably die out within the profession, and outside of it can have little practical weight.

Judging from what the honorary curator of the insect-collections of the national museum writes in to-day's issue, there is no important difference between his views and those to whose words he has objected. All agree that collections of insects need vigilant and unremitting care, and that any museum which does not guarantee that care is no fit depository of valuable collections. The question whether the national museum practically offers such guaranty is a nice one. Judging from the past history of the national collections in general, one would unhesitatingly say it did not. Judging, further, from Mr. Riley's own statements of the present condition of things, the same answer may fairly be given; for a large and growing collection, already one of the most important in the country, with no person in charge, or working under direction, whose services the museum can *command*, is plainly not a place which has any right to invite the deposit of unique objects. Notwithstanding this, the recent growth of the museum gives large, one is tempted to say abundant, hope that what has been accomplished means not only permanence, but progress; that, dependent as it is absolutely upon annual congressional appropriations, these will not entirely fail, since its hold upon both popular and congressional favor is such as to command respect and a certain amount of support. Though it may suffer temporary curtailment at times, it is already too strong to suffer long neglect or to be overthrown.

Nor must we forget that it shows hereby its very right to exist. In no country, more than in a republic, have institutions been more severely subjected to the law of 'the survival of the fittest.' With rare exceptions, all the scientific bureaus of the government are dependent for very life, from year to year, on the will of the people. The coast-survey even, with its extensive corps of picked men and all its refinement of work, unsurpassed by that of any similar body elsewhere, exists by virtue of an annual appropriation. However foreign this may be to the administrative ideas of European nations, it is thoroughly ingrained in our policy, a piece of the unwritten law of the land, a substantial part of democratic life. If through its agency the scientific bureaus of our government have reached their present status, and their work has received such generous praise abroad, even to self-reproach, to what may we not look forward when we consider that they have gained their present standing through the

action of an undying universal law which places before them two alternatives, — progress or death!

But to return to the practical question, whether the national museum is a fit place for the present deposit of unique collections of perishable objects, we may say, that, while the future of the museum seems to be assured, we have no sufficient historical ground for belief, that it will reach stability without serious lapses; and that until it supports a competent salaried chief of its entomological department, with at least one paid assistant, it stands in no position to invite the donation, or to warrant the purchase, of a single valuable collection of such perishable objects as insects. That the time will come when it is properly equipped, we cannot doubt; that it should reach it through the sacrifice of Mr. Riley's, or of any other choice collection, would be a burning shame: this is the immediate risk.

LETTERS TO THE EDITOR.

*** *Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

The voice of serpents.

PROF. C. H. HITCHCOCK's note in No. 104 brings to mind a fact noted in my laboratory, which may be of interest to herpetologists. In the autumn of 1883 a friend brought to me two magnificent living specimens of the common prairie bull snake, Pituophis Sayi. I gave them the freedom of my lecture-room, and they soon made themselves perfectly at home.

One day, while working with a large induction-coil, I bethought me of my snakes, and caught the larger (his length was about five feet), and passed a powerful charge of electricity through his spinal column. As the circuit was broken and made, I was much surprised to hear a faint though perfectly distinct cry from his snakeship. My notes made at the time speak of this sound as similar to the voice of a young puppy.

During a period of a month or more, this experiment was repeated with one or the other of these serpents, and always with this cry of pain or anger.

H. H. NICHOLSON.

University of Nebraska, Feb. 18.

The collection of insects in the national museum.

In reference to my remarks on the above-named subject, your explanation, that you meant 'the perpetual care of valuable collections' (p. 25), meets my criticism; and there would be no need to recur to the subject, were it not for Professor Fernald's communication on the same page. He there says, "The national museum has appointed an honorary curator, but it might as well be without one as to have one whose entire time is occupied elsewhere." Professor Fernald speaks here without knowledge, and under misapprehension of the facts. The honorary curatorship of insects is not 'worse than useless,' and the curator's time is not wholly 'occupied elsewhere.'

The organic law (Revised statutes, § 5586; Statutes forty-fifth congress, third session, chap. 182, p. 394) authorizes the director of the national museum to claim any collections made by other departments of the government. The national museum has a substantial fire-proof building, and a stable administration. The department of agriculture has a tinder-box, and the administration shares the uncertain influence of politics. Yet connected with the practical entomological work of the department of agriculture, there is much museum work proper; and since 1881, with the approval of the commissioner of agriculture, I have, as U. S. entomologist, looked upon material accumulated for the latter institution as belonging to the former, and have freely given my own time, and that of my assistants when necessary, to the entomological work devolving on the curator of said national museum. The two positions are naturally linked.

I am familiar with most of the insect-collections of the country, and believe, that, during the past three years, more original material has been collected expressly for the national museum, and more has been mounted for it, than for any other institution, not excepting the Agassiz museum at Cambridge, with its excellent insect department under Dr. Hagen; while, including the collection of the department of agriculture, and my own (which is deposited in the museum, and will be donated whenever such donation is justified), there has been by far more biographic work done for it than for any other museum. Even in the Micro-lepidoptera, it is probably next in extent to that of Professor Fernald. The care of museum material is of a twofold nature. The preservation of valuable type-collections requires vigilance, but little labor. The less labor, in some instances, bestowed upon them, the better; at least, so I thought last summer in witnessing the overhauling and re-labelling of Grote's collection in the British museum. The preservation and classification of original material, on the contrary, requires brains, time, and means.

The future and perpetual care of an entomological museum cannot be absolutely guaranteed without endowment; but appropriation to a government institution, though depending on the annual action of congress, is probably the next best security. Hence I agree with all *Science* has said as to the need of proper and substantial provision for such future care of the insect department of the museum. Washington is fast becoming the chief natural-history centre of the country; and the national museum is making rapid strides toward justifying its name, and offers, on the whole, as secure a repository for collections as any other institution. I speak of the museum as it is to-day, and not as it has been. The misapprehension indicated, whether an outgrowth of the amount of natural-history material that has gone to rack and ruin here in the past in other departments as well as in entomology, or a result of present rivalry, is certainly not justified to-day.

Professor Fernald truly remarks that "many museum officials have very little appreciation of the vast amount of labor, care, skill, and knowledge required" to properly manage a large and varied insect-collection. Things are too often valued by their size, and the pygmy bugs have not outgrown popular

contempt. The tail of a whale is no wise more complicated structurally, nor a whit more interesting morphologically, than the sting of a bee; but it occupies an infinitely greater space, and is more obvious both to the gaze of the curious and the study of the competent, — a fact which the management of a popular museum cannot afford to ignore.

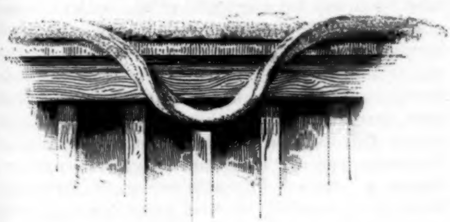
The national museum has very properly developed most in those departments, like ichthyology, geology, and ethnology, which receive, independently, government aid, and thus furnish both workers and material. If some of the other departments have so far been left without material support, those persons feel least like complaining who are familiar with the ultimate intentions of the director and his efficient assistant, and with the vast amount of work accomplished in organization and installation since the building was completed. C. V. RILEY,

Hon. curator of insects, U.S.N.M.

Washington, D.C., Feb. 12.

Plastic snow.

A phenomenon new to me was observed at the close of the north-east storm this noon, which showed the cohesive force in wet snow. The railing to my porch has a top sloping about ten degrees each way. My attention was directed to a festoon of snow sixteen inches and a half between ends, and seven inches deep, formed from a snow-ribbon. As it left the railing, it was gradually twisted, so that the bottom of the loop was in a position the exact reverse of what it had held when upon the rail. The twist-



ng-force had extended for a number of inches in each direction in the part that remained upon the rail. This loop hung free, and moved over an arc of five or six degrees when the wind struck it. It was of short duration, as the water from the rail melted the centre; and the ends, as they swung back, were broken off about four inches from the rail, and showed a spiral twist like that in a twist-drill. On the next panel was the end of a former loop; and this hung free, and measured nearly ten inches in length. EDWARD H. WILLIAMS, Jun.

Bethlehem, Penn., Feb. 16.

Hereditary malformation.

Mr. E. Brabrook writes to the society of anthropology in Paris an account of hereditary hypospadias, first reported to the *Lancet* by Dr. Lingard. The order of inheritance is as follows: first generation, one affected; second, one; third, one, whose widow afterwards married a man unaffected. This woman had seven sons — three by her first husband, and four by her second husband — all affected. I will divide these seven sons into the first and second set. Of the first three, one died childless: the other two had six sons, all affected. Of the second set were born eleven sons, — four affected, and seven unaffected. Three sons are reported of the first set in the next or sixth generation, two of whom are affected; while, of three sons belonging to the second set in the same generation, none are affected. Aside from the great value of such a compact series of well-authenticated facts, a very interesting question, often mooted among stock-breeders, of the permanence in the effects of first impregnations, receives here a partial answer. The running-out of this influence in a few generations should also be carefully studied. I do not speak of the transmission of hereditary traits of the male through the mother, because Dr. Lingard does not seem to have looked among the female descendants for co-ordinated malformations. OTIS T. MASON.

The Georgia wonder-girl and her lessons.

I read with no little interest the article with this title which appeared in this journal on Feb. 6.

I was privileged to make a private examination of Miss Lulu Hurst, the person referred to in the article, on several occasions, in the presence of her parents, and usually of her business-manager. On one occasion I was permitted to make a careful examination of the subject's physical development, and take notes upon her normal temperature, heart-beat, and respiration. I found her to be a healthy, intelligent country-girl, *plump* rather than muscular, presenting nothing very unusual in her constitution; and I certainly did not note the fact that I might be shaking hands with a 'giant.' The muscles of her arm and fore-arm were *not* unusually developed; nor did they stand out prominently, as they do in muscular subjects of either sex. She is above the average stature for women, but does not strike one as being either exceedingly active in movement or overpowerful in frame; as to the former, rather the reverse, I think.

Of the experiment with the staff, I shall simply state that in my case, on two occasions, the staff gyrated rapidly about its long axis, obliging me to quit my hold. This was observed by other persons present during the experiment. In the test with the hat, Miss Lulu stands before you with her hands extended horizontally, palms up, with the little fingers and sides touching each other. On the surface thus presented we place our hat, with the outer aspect of the crown resting on the two palms. The experimenter is then invited to lift the hat off. When I tried this experiment, the hat was only removed after considerable force was exerted, and then came away with a crackling noise, as if charged with electricity. That Professor Newcomb's explanation would not account for the result here, I would say that I knelt in such a position that my eyes were but a short distance away; and my line of vision was in the same plane with the opposed palmar surfaces and the crown of the hat. This latter was of very light Manila straw, with the outer periphery of the crown rounded. Now, as the form of this surface was a broad ellipse, with a major axis of perhaps seven inches, and a minor axis of six, quite smooth, it would be simply an impossible feat for Miss Lulu to seize it when the distance between the inner margins of the opposite thenar eminences in a right line is less than six inches.

Permit me now to present a test which Professor Newcomb did not witness. It consisted in standing upright, with one foot in advance of the other to act as a brace, and holding in the hands with a firm grasp an ordinary chair. This is to be done by seizing it at the rear uprights, about where the back joins the bottom; the former being towards you, and parallel with your anterior chest-wall, against which you

place your elbows at a convenient distance apart. This position evidently leaves a space between your chest and the back of the chair equal in length to your fore-arms, which are extended horizontally. Miss Lulu now takes a position beside you, and, holding her body back, simply places the palmar surface of her hand on the back of the chair on the side towards your body. After a few moments she seems to make the effort to detach her hand from the chair, which latter you are privileged to push forwards. The force at work, however, is too strong for you, and both yourself and the chair are carried backwards, without her hand having changed its position. The chair being a cane-backed one, it is evident that she could in no way gain a hold upon it, and the back of her hand never could come in contact with your chest, as the spanning of such a distance would at once be detected.

Professor Newcomb's conclusions, after having witnessed the test of lifting a chair with some one sitting in it, are to me far from satisfactory. I saw the girl lean over an ordinary chair, with a man weighing over two hundred pounds sitting in it, and placing the palmar surfaces of her hands on the outer sides of the rear uprights near their middles, and *without any* contraction of the muscles of the arm or fore-arm, or increase of pulse (remained at 80) or respiratory effort, or change of countenance due to exertion, so far lift that chair and its heavy contents from the floor as to compel the latter to get out of it; and this without fracturing any of the bones of her upper extremities, or the sides of the chair. The simplest computation will prove that the *lateral pressure* required must be enormous in order to get a hold, and prevent such a weight absolutely slipping between her hands when the upward force comes to be exerted.

R. W. SHUFELDT, U.S.A.

Fort Wingate, New Mexico, Feb. 19.

THE MICROSCOPE IN GEOLOGY.

MANY persons have heard that the microscope, everywhere recognized as indispensable in the investigation of organic nature, has also recently been made use of in geology; but very few have any distinct notion of the sort of problems to which it can there be applied, or of the way in which it can contribute toward their solution. The determination of the different minerals which compose very fine grained rocks may doubtless appear, even to many geologists who have been accustomed to deal with only great areas and mountain masses, a matter of small importance; and they often fail to see that the methods which render such a determination possible, are capable, if properly employed, of throwing much light on some of the most difficult questions with which they have to deal.

The microscopic study of rock-sections is one of difficulty, and indeed quite discouraging to a beginner who attempts it without proper guidance, no matter how familiar he may be with mineralogy, or with the use of the microscope in other fields of research. This fact, coupled with the newness of the branch, sufficiently accounts for the number of workers in it still being so small in this country, which presents unrivalled opportunities for its cultivation.

Although the idea of preparing rocks in transparent sections for the microscope originated with an Englishman, the fruitful line of research to which it gave rise has since been almost exclusively cultivated in Germany. Here the seed fell into soil made already fertile by the labors of older geologists, and sprang at once into a strong and rapid growth. The keen perception and great energy of Zirkel first made known the microscopic appearance of the common rock-forming minerals, as well as discovered the wide distribution of others before considered rarities. Vogelsang, not contented merely to observe, was able to draw from his studies the most suggestive conclusions, which he substantiated by ingenious and delicate experiments. It is, however, to Rosenbusch that the development of petrography as a science is most largely due. In his work, published in 1873, he showed in a masterly manner how what had been learned of the optical properties of different crystals, especially their action on polarized light, could be applied to their identification in thin sections, thus rendering a rigid microscopic diagnosis for the first time possible. From this time on, the interest in this branch of investigation became in Germany very general, and its growth proportionately rapid. The attainment of the long-desired separation of rock constituents, even when of the smallest size, by means of solutions of high specific gravity, and the perfection of many micro-chemical reactions of great precision, followed each other in quick succession, until to-day the accuracy and beauty of petrographical methods are hardly second to those found in any other branch of natural science.

The geologists of other countries on the continent, especially in France and Scandinavia, soon perceived the value of the German work, and early availed themselves of its results to start similar investigations in their own countries. It is a surprising fact that the appreciation of it among English-speaking people has been so slow, that not one reliable text-book on the subject of petrography exists in the language of the man who gave the first impulse to its modern development. Any knowledge of the subject in America is recent, dating from the publication of Zirkel's 'Microscopical petrography' in 1876. How steadily the inter-

est in it is increasing, however, may be judged from the number of American students who have been and still are pursuing it at various German universities. What is needed in this country are well-equipped petrographical laboratories, so that those who are unable to avail themselves of the facilities which Europe affords may not be compelled to remain in ignorance of what is daily becoming a more and more necessary part of a geologist's training. An attempt to organize such a laboratory has recently been made at the Johns Hopkins university and the encouragement which it has already received seems to abundantly justify the experiment.

Heretofore microscopical petrography has been essentially a branch of mineralogy, but its future certainly lies in the far wider sphere of geology. The mere laboratory study of isolated rock-specimens, which has served so good a purpose in the perfecting of delicate and accurate methods, no longer possesses any significance, now that these are so thoroughly developed. What in Germany has been secured by years of patient labor may now be learned in a comparatively short time. Geologists have only to know and realize its application to their field of work, in order to eagerly avail themselves of such an important aid. The use of the microscope alone will in future produce but little that is new; but its possibilities in geology, when intelligently employed in connection with the most detailed and careful field-work, — the necessity of which has been increased, not diminished, by its introduction, — cannot be easily overrated.

What paleontology has done for the fossiliferous deposits, this, and even more, the microscope must do for the crystalline rocks. The less altered forms of igneous masses have thus far been almost exclusively studied; and, although they still have much to teach us, it is not by their investigation that the microscope is destined to yield its greatest assistance to geology. The changes, structural and chemical, which go on in rocks after they are first formed, leave behind them more or less distinct traces which it is the special province of the microscope to follow out and interpret. Of how much has already been learned regarding the alteration of sedimentary rocks near their contact with eruptive masses, the work of Rosenbusch in the Vosges Mountains, of Lossen in the Hartz, and of Hawes in New Hampshire, is abundant proof. The wide-spread changes which rocks subjected to regional metamorphism have undergone, are far more complicated and difficult, but they can undoubtedly be studied with as great success. It is by dealing with such problems as Lossen, Renard, and Lehmann, in Europe, and Wadsworth in this country, have especially pointed out, that the microscope in geology can in future render its best service. The manner in which this can be accomplished is by the patient following, step by step, of unchanged rocks into their most completely altered equivalents, and carefully comparing the condition of each constituent at every point. In this manner the succession of changes which they undergo may be as completely worked out as though we could see the process actually going on before our eyes. The alterations of olivine and enstatite to serpentine, of pyroxene to hornblende, and even the reaction of two minerals upon each other in forming a third of intermediate composition, as shown in the rim of amphibole which surrounds olivine where it is in contact with plagioclase, have all been traced by the microscope through every stage. More recently the effects of pressure exhibited by the bending and breaking of crystals, the disturbing of their optical characters, and the local crushing of the rock constituents, have been carefully studied. This is found almost always to be attended by the formation of new minerals, like albite, zoisite, mica, garnet, etc., whose younger origin is only to be proved by a microscopic investigation. It is impossible to mention here a tithe of what has already been done in this direction, although a beginning has hardly yet been made. What are especially to be desired are detailed studies of many small areas, where the same rock, whether eruptive or sedimentary, can be traced from its original form to its most altered state, and a comparison of the results obtained in each. This Lossen[1] has recently attempted for the southern Hartz, and has thereby indicated what is perhaps the most promising field for microscopic work in geology.

GEORGE H. WILLIAMS.

THE SPANISH EARTHQUAKES.[2]

THE Spanish peninsula has been the scene of a series of earthquakes, which, for extended duration and disastrous effects, surpasses any thing that has been felt in that region in recent

[1] Studien an metamorphischen eruptiv- und sedimentgesteinen, erläutert an mikroskopischen bildern. Jahrbuch der preuss. landesanstalt für 1883, p. 619.

[2] In preparing this notice, the following journals have been consulted; viz., Cronica cientifica (Barcelona), Science et nature, La Nature, L'Astronomie, Comptes rendus, Cosmos, Hansa, Nature, and various English and American newspapers.

years. Beginning toward the close of December last, the shocks continued at intervals for more than a month, and, indeed, the ground has hardly yet resumed its wonted stability; while the loss of life and destruction of property, exceeding that of 1829 in Valencia, has perhaps not been equalled since the great Lisbon earthquake of a century ago.

The first light shocks were reported in the early morning of Dec. 22, 1884, at Pontevedra and Vigo on the north-west coast, and were also felt at Lisbon and other places in Portugal, on the island of Madeira and the Azores.

This was followed on the evening of Dec. 25 by disastrous shocks in the southern part of the peninsula. They began at 8.53 P.M., being felt as far north as Madrid, where bells were rung and clocks stopped, but doing no damage there; while in the southern provinces of Andalusia, Granada, and Malaga, where the principal force was expended, hundreds of houses were overthrown, hundreds of lives lost, and some towns and villages entirely destroyed.

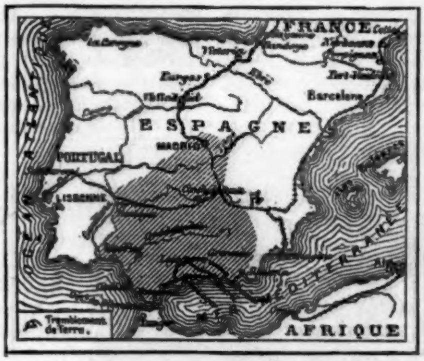
VIEW IN A STREET OF ALHAMA, JAN. 3. (From *La Nature*.)

In Cadiz, Seville, Cordova, Jaen, and Almeria the shocks were strongly felt, injuring some buildings, but without serious damage. At Granada, shocks to the number of eight occurred during that night; and, besides other casualties, the front of the cathedral was injured, the Alhambra fortunately escaping harm. The villages of Albuñuelas, Arenas del Rey, Jatar, Zafarraya, and Santa Cruz, were left a mass of ruins. Alhama was destroyed with the loss of over a thousand houses and three hundred and fifty lives. This town consisted of two parts, — an upper and a lower. The upper portion, situated upon the higher ground, was cast down upon the lower, overwhelming it in its fall. The hot springs also ceased to flow for two days, after which, the flow was resumed more abundantly than before. The waters have since then acquired a marked sulphurous character, and their temperature has increased from 47° C. to 50° C.

The province of Malaga also suffered severely. In the city of Malaga all the public buildings were injured, and some were destroyed with many other houses. At Estepona, on the coast west of Malaga, a church and a block of buildings were destroyed. At Torrox, Nerja, Almuñecar, and Motril, places on the Mediterranean Sea east of Malaga, many buildings were overthrown, and many lives lost. In the first-mentioned place, as stated by the alcalde, twenty-six shocks occurred between 8.50 P.M. of the 25th and 11 A.M. of the 26th, completely destroying the village. At Almuñecar twelve shocks occurred in fifteen minutes. At many places where the destruction was less complete, especially at Granada and Malaga, the inhabitants camped for days in the fields and open places, sleeping in tents and sheds, or in carriages, not daring to return to their houses. At Periana, north of Malaga, an extensive land-slip was caused by the earthquake, overwhelming a large part of the town, and destroying a church and seven hundred and fifty houses. Above the village of Guevejar, built upon a hillside, a great parabolic crevasse three kilometres long has opened to a width of from three to fifteen metres; and the village, which rests on a stratum of clay, is slowly sliding downward to the valley, while the houses still remain standing. Some of the houses have moved twenty-seven metres since Dec. 25.

At one extremity of the crevasse a small lake has been formed, having a depth of nine metres, and a superficial area of about two thousand square metres. At another point an olive-tree has been split from root to branches, the two parts remaining upright upon opposite sides of the opening. At still another point, it has divided lengthwise the foundation-wall of a powder-manufactory.

As many of the villages in that part of Spain do not have telegraphic communication with the capital, details have been reported slowly and with considerable uncertainty; and it is difficult to gather from the various accounts any estimate of the whole number of lives lost.



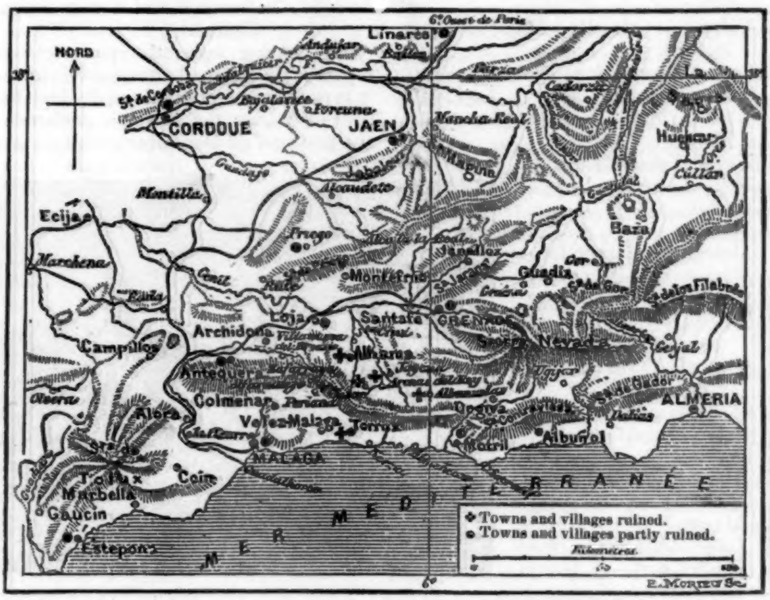
MAP OF SPAIN. THE REGION AFFECTED IS SHADED. (From *La Nature*.)

numbered by thousands, and the villages of Alhama, Santa Cruz, Arenas del Rey, Periana, and Albuñuelas are now but piles of ruins. More than thirty-five villages are named where some dead and wounded were taken from the ruins. Of the 10,000 houses in Malaga, 7,000 will require repairs.

The shock of Dec. 25 was succeeded by lighter shocks on the remaining days of the month, and at longer intervals through the month of January, and, indeed, up to the present time. A list of the shocks is as follows: —

Dec. 22. Pontevedra, Vigo, Lisbon (3.29 A.M.), Madeira, Azores (2.30 A.M.).

24. Seville (light).



MAP OF THE REGION SUFFERING MOST SEVERELY. (From *L'Astronomie*.)

On Jan. 14 the official records stated for Granada 695 killed and 1,480 injured. Other estimates have placed the entire loss of life at upwards of 2,000. The houses destroyed are

Dec. 25. Madrid (to the Mediterranean, etc., as above).

26. Madrid, Gibraltar, and the southern provinces.

Dec. 27. Antequera (five shocks), Archidona (nine shocks), Malaga.
28, 29. Torrox, Malaga.
30. Velez Malaga, Torrox (7 and 10 A.M.), provinces of Granada and Malaga.
31. Torrox, Granada, Jaen (6.35 P.M.), Malaga.

A RUINED STREET IN ALHAMA. (From *Cosmos*.)

Jan. 1. Torrox, Granada (11.45 P.M.), Malaga, Nerja (2, 6.45, 9 P.M.), Algarrobo, Alhama, Antequera, Valencia.
2. Valencia, Granada, Malaga, Velez Malaga.
3. Loja, Alhama, Jaen, Velez Malaga.
5. Granada (6 P.M., severe), Loja, Motril (fifty houses destroyed), Malaga.
Jan. 7. Nerja, Velez Malaga.
8. Loja, Torrox.
9. Torrox.
10. Malaga.
11. Malaga (buildings fell).
12. Gibraltar, Alhama, Algarrobo.
13. Torrox, Canillas, Almuñecar, Algarrobo.
16. Granada (10 P.M.), Canillas, Motril.
21. Malaga, Loja, Velez Malaga, Almuñecar.
22. Periana.
27. Alhama (one person killed).
Feb. 12. Alhama.
13. Torre del Campo, forty miles north of Granada (serious damage to hospital).
14. Granada, Velez Malaga.
23. Granada (renewed shocks reported).
March 2. Granada, Loja, Alhama (houses fell).

The severe shock on Christmas night seems to have been perceived in England, having been reported as felt at 10.20 P.M. in Wilts, and also having been recorded by small disturbances of the magnets in the Greenwich observatory at 9.15 P.M.; the suspended magnets acting as pendulum seismographs.

While they may probably have no connection with the Spanish earthquake, the following shocks, felt in other parts of Europe during the same period, are worth noting; viz., —

Dec. 25. At Zernetz, Engadine (at 8.17 and 11 P.M., the former hour corresponding to 7.32 P.M., Madrid time).
27, 28. At Tarvis in Carinthia.
28. 7 A.M. at Sundal and Öxendal, Norway.
29. In Wales.
Jan. 4. In Styria.
5. 3 A.M. at Chambéry, Savoy; 5.50 A.M. at Embrun.
Jan. 6. In Italy at Susa, near Mont Cenis, and at Velletri.
21. Between 0 and 1 A.M. at Ennenda, Glarus.

As bearing upon the possible connection between seismic and atmospheric phenomena, it is remarked that an unusually high barometer prevailed over the Spanish peninsula during the first half of December; while from Dec. 20 to 22 a heavy storm area, attended by an unusual atmospheric depression, was passing from north to south over the same region, reaching the Mediterranean on the 22d; also that at Nerja a hurricane followed the first shocks,

RUINS OF A CONVENT, ALBUÑUELAS. (From *La Nature*.)

blowing down the houses, whose walls were already weakened by the earthquake.

The geological characteristics of the country are described in the next article: it will therefore suffice here to say that the seismic phenomena seem to be intimately related to the geological growth of the mountain system, especially the Sierra Nevada, the elevation of which is apparently not yet completed. A commission, consisting of three mining engineers, under the presidency of Sr. D. Manuel Fernandez de Castro, has been appointed by the Spanish government to study this series of earthquakes, and has already distributed a list of thirty-three interrogatories relating not only to the time, direction, and other particulars of the earthquake shocks, but also to various atmospheric phenomena, such as the pressure, temperature, clouds, etc.

C. G. ROCKWOOD, Jun.

THE SIERRA NEVADA OF SPAIN: THE SCENE OF THE RECENT EARTHQUAKES.

THE Sierra Nevada of Spain, though full of interest for the tourist, the man of science, or the student of history, has been little visited, and almost nothing has been written about it.

This sierra forms a compact body, twenty-five miles wide and fifty miles long, completely isolated, and without directly connected lateral spurs or terminal ridges. Surrounded by an alluvial plain as it is, it has, nevertheless, certain smaller neighbors which seem, like itself, to have been ejected from below. Its crest has been denuded by the elements, and its sides scored by brooks or torrents which diverge in all directions from the central axis, fed by the rains of spring and the melting snows of summer. Four principal streams, descending to the north-west, meet at the very foot of the Alhambra, and unite their waters before traversing the renowned plain of La Vega. Their cascades and ripples, descending from the mountain crest above, give to the adjoining valley a delicious freshness during the torrid months of summer. To these waters is due the immense isle of verdure presented by the Vega at a time when nearly all southern Europe is scorched dry by the sun. At many points the rivers run in narrow, deep channels easily dammed. From their sources to the moment when they reach the plain, their average descent is one to ten, almost the maximum for running waters. At that point they are captured: not a drop escapes. All the irrigating works and canals, the customs governing the distribution of water, even the rules recalled by the strokes of the bell nightly from the minarets of the Alhambra, are the legacy of the Arabian civilization which blossomed on the plain before it was driven to a last refuge on the mountain.

On the north, three rivers descend to the plain of Guadiz; but, their sources not being fed by perpetual snows, when the rainy season has passed they dry away. In consequence this plain is as sterile, bare, and forbidding as that of the Vega is green and inviting. Wherever the eye wanders, apart from the sierras, lies a reddish-gray plateau of dusty alluvium, seamed and rent by precipitous cañons. Nothing recalls the idea of life: the desolation is as that of an unknown country, grand and terrible. All the valleys and plains of this part of Andalusia present the same impressive and melancholy features. Gustave Doré, who passed through this region many years ago, has profited by his experience to introduce memories of it in some of the most strange and fantastic productions of his pencil. This sterile region is poor, unpeopled, almost unknown, and practically cut off from communication with the rest of Spain.

Farther to the west is the country of the Alpujarras, so celebrated in Moorish history for the terrible conflicts of which it was the theatre. More than one poet has celebrated the combats of the Christian and the Moor in the narrow defiles and rocky gorges of the sierra; but all these imaginary descriptions fall far short of depicting the scene as it appears in reality.

The Alpujarras are composed of two cistern-like basins, absolutely closed to the outer world, except by two narrow gorges cut in the rock by the rivers which traverse them. The first of these rivers, the Rio Grande de Ujijar, descends directly from the heights of the Sierra Nevada, passes by the site of that town, and, with its affluents, waters the basin of Ujijar, the ancient capital of the little Moorish kingdom. It issues by a deep cañon, and falls into the Mediterranean by the little port of Adra at no great distance. The second, the Guadalfeo, runs between the Sierra Nevada and Contraviesa, close by the former, whose slopes it drains. Emerging from the basin, it turns abruptly to the south, reaching the sea near Motril. Just before entering the gorges of the Sierra Contraviesa, the Guadalfeo receives the brook of Beznar from a point elevated above the plain of La Vega, whence Boabdil, the last of the Moors, is said to have

taken his parting glimpse of his palace of the Alhambra, the rich Vega, and 'Grenada the marvellous.' It is appropriately named 'Suspiro del Moro' ('the Moor's sigh').

A very few men can safely hold the entrances to the Alpujarras; and they long remained the last stronghold of the Arab power in Spain, which has passed, leaving as its memorial little more than the names of a few villages, and the wonderful system of irrigating-works.

There can hardly be a doubt that the series of calamities, hardly closed, which has laid so many villages in ruins since last Christmas, is a continuation of the processes by which portions of the earth's crust are raised in mountain ranges above the rest. A few words on the geological structure of the sierra may indicate the possibilities of the locality. The structure of the sierra and its neighbors is quite simple. They rise like islands or domes of ancient mica schists out of a sea of later formations, which break like waves upon their flanks. These schists are of a silvery white, appearing like snow when distant and illuminated by the sun. They are absolutely sterile, but dip, in a general way, outward from the central axis of elevation in all directions. A belt of radiately dipping Silurian schists encircles the central part of the sierra, which, like the exposed part of the core, assumes rounded outlines, but is succeeded by another belt, rugged, precipitous, and craggy, of Permian limestones, which extends to the base on the eastward, but is nearly as irregular in height as in extent. The Alpujarra basins are excavated in these limestones, and protected by escarped cliffs. Against the base of the sierra, raised slightly near the mountains, but elsewhere horizontal, lie tertiary grits, clayey sands and clays, deposits of fine gypsum, etc., covered with two alluvial series of beds, — the lower composed of decomposition products of the Silurian schists, brought down by water and mingled with material derived from the subjacent tertiary; the upper and later, from the denudation of the fundamental mica schists now forming the crests of the sierras. Moule observes that the elevation of the sierras has, in part at least, taken place since the tertiary epoch, and even since the alluvial period, and that it may not yet have ceased. This observation, written before the recent disturbances, has found in them renewed support.

The people of the country, finding in the elevated blocks of argillaceous alluvium left isolated by the torrential rains of part of the year a soft but compact and resisting material, have carved in them whole villages of cave-houses, with doors and windows, and often with one story above another. These abrupt elevations, though of moderate height, are extremely numerous, entirely without vegetation, and of an ashy hue. The cave villages are numerous, and, as in the case of Purullana, contain sometimes several hundred inhabitants. One may imagine the devastation among these gnomes which an earthquake shock must produce, and which would go far to explain the great loss of life in these small places.

The shocks felt have been chiefly to the westward of the Sierra Nevada, and have been most severe along the junction of the tertiary rocks with the schists. Here towns have been almost or quite destroyed, and the ruin wrought has been largely proportional to the proximity of the town or village to the unconformability of the rocks, though the motion has been propagated over a much wider area.

THE WORK OF THE SWISS EARTHQUAKE COMMISSION.

THE Swiss earthquake commission was appointed by the Swiss society of natural sciences, in 1879, to secure more uniform and accurate observation and study of the seismic disturbances in and around the Alps. It included such men as Forel, Forster, Hagenbach-Bischof, Heim, Soret, and others of mark as physical-geographers and geologists; and they at once began an active campaign. Professor Heim of Zurich wrote several general articles[1] to call attention to the undertaking, and to outline the method by which intelligent persons could give effective assistance; and since then, he and Forel, both admirably qualified, have prepared a number of monographic reports on the results thus far reached. The official journal of publication is the *Jahrbuch des tellurisches observatorium* of Bern; but, so far as I can learn, none of our libraries possess a copy of it. Fortunately, the reports have mostly been reprinted in periodicals of more general circulation, and from these the notes here presented are derived.

Forel's entertaining papers[2] give the results of the

[1] Ueber die untersuchungen der erdbeben und die bisherige resultate. *Zurich vierteljahresschr.*, 1879.

Die erdbeben und deren beobachtung. Zurich, 1880. This appeared also in French, translated by Forel, in the *Arch. des sciences*, iii. 1880, 261.

Die schweizerischen erdbeben von November 1879 bis ende 1880. *Jahrb. tellur. observ.*, 1881; with an appendix giving important corrections.

[2] Les tremblements de terre étudiés par la commission sismologique suisse de novembre 1879 à fin de 1880. *Arch. des sciences*, vi. 1881, 461.

Id. . . . pendant l'année 1881. *Arch. des sc.*, xi. 1884, 147.

Les tremblements de terre orogéniques étudiés en Suisse. *L'Astronomie*, ii. 1883, 449; iii. 1884, 13.

commission's work in attractive form. It is sometimes even a little amusing to notice the purely scientific treatment that these distressing calamities receive; for, just as an old surgeon will describe a terrible operation as a 'beautiful case,' so Forel writes of a violent shock as 'ce beau tremblement de terre.' Spain must advance far beyond its present superstitions before it can have so calm and judicial a commissioner. The classification that was early adopted is an important matter, and, in the present stage of the study in this country, deserves quotation in full; for, in any statistical comparisons, it is important that the facts on which they rest should be recorded on similar scales. The first principle is the grouping of the fainter antecedent and subsequent tremors with the more violent shocks, as making parts of a single disturbance; and, although this is generally well advised, it sometimes leads to including shocks (*secousses, stossen*) that occurred during ten or more days as parts of a single earthquake (*tremblement, beben*). Thus, in 1880, there were sixty-two tremors or shocks in twenty-one earthquakes; and in 1881 the numbers were one hundred and sixty-three, and thirty-seven for Switzerland alone. The intensity of shocks is measured on the Rossi-Forel scale, as follows: —

1. Very faint; recorded by a single seismometer; noticed only by practised observers.
2. Registered on several seismometers of different construction; noticed by a few persons at rest.
3. Duration or direction noted; felt by a number of persons at rest.
4. Felt by persons while moving; shaking of movable objects, doors, windows; cracking of ceilings.
5. Felt by every one; furniture shaken, and some bells rung.
6. Sleepers awakened; general bell-ringing, clocks stopped, visible swaying of trees; some persons run out of buildings.
7. Overturning of loose objects; plaster falling, general fright; buildings not seriously injured.
8. Chimneys falling; walls cracked.
9. Partial or total destruction of buildings.
10. Great disasters; overturning rocks, forming fissures and mountain-slides.

In order to obtain a measure of the 'value' of the earthquake in which all its elements are included, the area affected and the number of accessory shocks must also be considered. For Switzerland, the areas are grouped by diameters of five, fifty, one hundred and fifty, and five hundred kilometres; and the weak, medium, and strong accessory tremors are counted separately (n, n', n''). Then the total value of a disturbance is $V =$ (Intensity scale $\times$ area scale) $+ n + 2n' + 3n''$. This is evidently a useful method of combining and giving weight to the various peculiarities of an earthquake, but it has a manifest inaccuracy coming from the inequality of the divisions in the scale of intensity. Great earthquakes would not be given their deserved superiority over small ones in such a measurement. It would be improved by squaring the intensity number of the principal shock.

The numerical results thus far announced may be briefly summarized: they give a moderate winter maximum, thus agreeing with Volger's studies of some years ago; a strongly marked preference for the night hours, with a maximum between two and four in the morning, while the minimum is from noon to two o'clock in the day; no sufficient connection is made out between the attitude of the moon and the occurrence of shocks; and the south-western corner of the country has had twice as many earthquakes as any other, but no general map showing distribution has yet been published.

There seems to be no dissent from the opinion that these shocks are in no way of volcanic origin: they are by all regarded as evidence of continued structural disturbance and growth of the Alps. There is no appearance of volcanic action, but evidence of lateral crowding is afforded by every valley that exposes sections of distorted rocks on its sides. The distortion may be slow and uniform, and evenly distributed through the rocks, especially when far below the surface, under the heavy weight of overlying strata; and then it is probable that no disturbance would be felt above. But it may also be irregular by fits and starts, as the crushing stress accumulates to the limit of the rocks' strength, which snap asunder as the limit is passed; and the tremor thus produced is known on the surface as an earthquake. The migration of shocks gives valuable confirmation of this view. Some earthquakes, composed of a number of accessory shocks having a common centre, are properly referred to a single origin: examples of such are found in 1879, vii., and 1880, i., ix., xiii., and xx., of Forel's lists. But in a few other cases the successive shocks must be referred to different centres, which travel or 'migrate' along a line that is naturally supposed to mark a yielding fissure. 1879, v., and 1880, viii., belong to this interesting class. Still more peculiar is the interpretation given by Heim to number xlvii. of his list (June 28, 1880). The observations of this earthquake showed only a moderate velocity of propagation (112 to 204 metres a second) in the direction of the longer diameter of the region affected, and this is regarded as too small for the advance of an elastic earth-wave. Moreover, the local directions of the shock, agreeing fairly well among themselves on either side of the longer diameter, did not agree with the direction of the extension of the disturbed area in time. It was therefore supposed that the disturbance resulted from the successive breaking or slipping of a long fissure, from which earth-waves spread out laterally with normal velocity; thus showing the migration of the focus quickly accomplished in a simple earthquake, much as it had been implied by the more deliberate shifting of the successive shocks in complex disturbances. The explanation is a tempting one, and, if confirmed by similar results in the future, will be an important contribution to seismology.

The statistical results that will, after a few decades, be gathered from these uniformly recorded observations, will be of especial value; and the further development of the connection that has been surmised

between the disturbed areas and the structural features of the Alps will be looked for with interest.

W. M. Davis.

THE CAUSES OF EARTHQUAKES.[1]

I have followed with much interest the details upon the recent earthquakes, which the newspapers have published; but this question is so intricate, so difficult, that I assure you I should not have undertaken its investigation had I thought any other person would have been willing to do so. Meanwhile, at the academy, the question is growing in importance, geologists, geodesists, and others having taken it up with considerable enthusiasm. Under these conditions, I have thought that I ought not to draw back. Nevertheless, I am not without a certain apprehension. Indeed, the question of earthquakes is one of the vaguest. Data are hitherto wanting, but there is no lack of theories; for as in medicine, when there are many remedies for one disease, it is frequently the case that neither is really good, so in geology, in terrestrial physics, when many theories are put forward to explain a phenomenon, it is necessary to cast aside each, and say that none is absolutely sufficient. I start, then, with a certain hesitation; and yet, when one accepts an appointment to study facts of this sort, it seems to me necessary to have in mind some theory, true or false, and to adopt it more or less boldly, free to abandon it after contradiction.

I start, then, with a certain idea which I expect to verify or invalidate. I do not propose to tell you what it is: I will simply ask your permission, before giving my plan of studies, to point out in a few words the current theories to account for earthquakes.

There are four principal ones. They are very old. We find them in the Greek authors, and perhaps, if one were to search carefully, they would be found among East-Indian traditions. The first is based upon the supposition, that, under the solid crust of the earth, the sudden generation of gases and vapors causes subterranean explosions; and it is the effect of these shocks that we feel on the surface. This would be in a way comparable to an explosion of dynamite taking place at a great depth. I need not discuss these theories, yet I may say that perhaps this one is true when applied to earthquakes in the neighborhood of volcanoes. It is certain, indeed, that as soon as the earth opens, great quantities of gas are liberated from beneath the surface, where in some way they have been generated and furnished with extraordinary power.

But even if this theory is probable with regard to volcanic earthquakes, I think that it would be difficult to apply it to those in Spain.

A second theory has been proposed by a learned physicist, Alexis Perrey. It is based upon the supposition that the combined influence of the sun and moon, acting upon the liquid parts beneath the surface, produces tides analogous to those on the surface of the earth. These vast tides of liquid fire at certain favorable movements, striking upon the solid external crust, cause the earthquake shocks. I also abandon this theory, for I do not think it can apply to Spain.

There remain two others, one that of Scheuchzer, a distinguished *savant*, at once paleontologist, geologist, and physicist. Having studied the earthquakes in Switzerland, he has attributed them, not without reason, in certain particular cases, to the falling-in of subterranean caverns caused by the dissolving-out of such substances as salt or gypsum by water which has penetrated beneath the surface. Such a collapse would, without doubt, cause a very appreciable shock at the surface of the earth. This theory may apply to certain special cases; but it remains to be seen if it applies to the Spanish earthquakes.

There is a fourth which is at present in favor in Germany among nearly all geologists of that country, and it has also been accepted by some in other countries. In France it has not been so well received: nevertheless, there are eminent men who entertain it. It is based upon geological observations. There are no geologists, indeed, who, observing the walls of the cracks in the metamorphic rocks, for instance, have not been struck by the fact that these beds, originally deposited in a horizontal position, have been raised and broken. There have evidently been movements of extreme importance, since rocks that were originally connected and regular are now in the greatest disorder. Now, it is certain that these movements could not have been produced without superficial shocks at the moment when the fissures were made. Therefore there must have been earthquakes in all geological epochs, even the most ancient, which are exactly comparable with those of to-day. But reciprocally, if these ancient foldings have produced earthquakes, why are not the present earthquakes the result of analogous phenomena?

You see that the theory is perfectly regular up to this point. It is only necessary to know (the difficulty is merely thrown back in time) what is the origin of these foldings, of these fractures. Why these out-throws, these subsidences, these convolutions? We then arrive at a very old explanation, given by geologists, and still admitted by many *savants*. It is that the earth is continually cooling, and so contracting. The superficial crust has reached a nearly constant temperature; but this is not true of the liquid portions adjacent to it, where the temperature must be very high, though constantly cooling. In cooling, its volume becomes less, and its contractions cause foldings and fractures in the solid crust. This theory is rather old, it is true, but there is no better theory at present.

As to the Spanish earthquakes, it seems to me, that, of these four theories, only two should receive any attention.

The question is, therefore, whether there are fissures, bendings, and faults beneath the surface, or whether the water is dissolving out caverns. In a

[1] A communication to the French geographical society, on Jan. 23, by Mr. Fouqué, professor of geology in the Collége de France, and chief of the commission appointed by the Academy of sciences to study the Spanish earthquakes.

word, the subject for research is whether one of the last two theories will apply to the case in question. You will notice, moreover, that each of these theories presumes a geological cause. It is in part, I think, this idea of the connection between earthquakes and the movements far below the surface, that has influenced the Academy of sciences in choosing a geologist to examine the phenomenon.

In my turn, — and for the same reason as the Academy of sciences, — I have taken geologists as collaborators. Those who accompany me are Messrs. Michel Lévy and Marcel Bertrand, members of the geological survey of France, and mining engineers of great competence. The third who accompanies me is Professor Barrois, of the Faculty of science at Lille, an eminent geologist, who is well acquainted with the Spanish soil.

I have, then, as my associates, three geologists, perfectly competent to study all the facts that are usually investigated in earthquakes, — the propagation of the motion, the direction of the shock, and the place of greatest intensity. They are also capable of determining the relations which exist between the superficial action of an earthquake and that which may be going on at great depths. Geologists, when they travel over the surface of a piece of ground, see not only the superficial beds, but, by a sort of instinct, they divine the character of the deeper extensions. Sometimes they are mistaken, — they are not infallible, — but still, in the most cases, they are able to determine the constitution of the deep strata. This, then, is one special point which we shall endeavor to determine.

We wish, from the study of the superficial deposits, to deduce its geological structure at a certain depth. On the other hand, with the means which we possess to-day, it is possible to determine approximately the depth from which an earthquake shock originates. We have two methods for this. One, which is founded upon very precise and delicate observations, has been proposed by Mr. Seebach: it is based upon the determination of a series of points, in which the oscillations are felt at the same moment. These observations are extremely difficult to obtain.

There is another, older method, due to the English physicist, Mallet. The system of observations proposed by him is based upon the examination of the cracks in the land after an earthquake. These fractures are, in nearly every case, normal to the direction of the shock; and, when one studies them carefully, the direction of these normals is sufficient to fix their points of convergence, and hence the origin of the shock.

The methods of which I have spoken are not purely theoretical: they have been applied five or six times by Germans, Italians, and English; but, unfortunately, the French have not yet used them. They have given very interesting results; as, for instance, in the last earthquake at Ischia, it has been shown that the cause of the concussions came from a depth of from twelve hundred to eighteen hundred metres at the most. Between twelve hundred and eighteen hundred metres there is certainly a considerable range; but one would have expected to find that the shock came from a much greater depth. Consequently much is already accomplished, when we can limit the origin of the phenomenon to a space so restricted.

I said that we were able to apply these two methods, the one certainly, the other probably. We may thus ascertain the depth of the earthquake's centre. If, on the other hand, we are able to determine by geological observations the constitution of the earth at this point, we shall have obtained a datum extremely important, and we may be able to accept one of the two theories, or so to limit one or the other as to make it agree better with the facts.

These are the objects of our mission, these the things we count on accomplishing. You will see that it is very simple. I hope that we shall obtain satisfactory results. I do not dare to promise that we shall; but I do promise you that we shall study Andalusia, or a portion of this province, with care, and that we shall bring back data of geological interest and importance from this very curious country.

SEISMOLOGICAL NOTES.

THE earthquakes of the last year in England have, like those in this country, aroused an interest in seismometry; and the committee of the Scottish meteorological society, who have charge of the Ben Nevis observatory, have asked Professor Ewing (whose work in Japan we recently noticed [vol. iv. p. 516], and who is now professor of engineering in University college, Dundee) to institute earthquake observations on the top of Ben Nevis. Professor Ewing has received a grant of a hundred pounds from the committee controlling the government grant for scientific investigation, and will proceed to set up apparatus to detect, and probably to record, minute earth-tremors, and also slow changes of level of the ground.

In connection with the recent Spanish earthquakes, it is interesting to note that we have accidentally brought into prominence a new kind of seismoscope. In *Nature*, vol. xxxi. p. 202, Mr. Ellis of the Royal observatory at Greenwich states that the continuous photographic records of the declination and horizontal force magnetometers both show a simultaneous disturbance, different from the ordinary magnetic disturbances, occurring on the evening of Dec. 25, a few minutes after the reported time of the severe earthquake in Spain on that date. No ordinary magnetic disturbances were recorded on this and neighboring dates, and the earth-current registers showed no change; so that there would seem to be little if any reason to doubt that the unusual disturbances recorded were caused by the swinging of the magnets on their suspending fibres, due to the shaking of the points of suspension by the Spanish earthquake. If some method were devised of photographing the lateral swing of the magnets in two azimuths at right angles, in addition to the present torsional swing as magnetometers, these instruments could, perhaps, be made very sensitive seismoscopes as well, and the accuracy of the time-record would only depend upon

the velocity given to the strip of photographic paper. Of course, as *seismometers*, they would be as worthless as all stable pendulums must be; but as *seismoscopes*, they might be quite sensitive, and the expense and requisite attention need not add greatly to that already necessary with the magnetometer.

In Japan, Professor Milne keeps up his active work in seismology. During the last summer, he spent five days on the top of Fujiyama, attempting to detect diurnal changes in the level of the ground. The results have not yet been published. This mountain — a wonderfully symmetrical volcanic cone, about twelve thousand feet high, and the most striking object in all Japan — is the one on whose summit Professor Mendenhall made a determination of the force of gravity and of the values of the magnetic elements; and it will always be an interesting point for scientific observations of all kinds, rising as it does in complete isolation out of a plain.

In vol. vii. part 2, of the *Transactions* of the seismological society of Japan, Professor Milne contributes a paper upon three hundred and eighty-seven earthquakes observed in northern Japan between October, 1881, and October, 1883. A map is given for every quake, showing by its colored portion the approximate area covered by the shock, as determined by Professor Milne's system of tracking down earthquakes by a system of postcards distributed to all important places in the hands of observers who send in weekly reports of the occurrence or non-occurrence of any disturbances. In this way Professor Milne has had the northern part of Nippon and the southern part of Yezo covered for several years with a network of forty-five observers, besides those in Tokio and Yokohama. At five of these stations quite accurate time-observations of the disturbances were frequently obtained by the help of good clocks compared several times per week with the daily telegraphic noon signal from Tokio. A catalogue of the individual observations of each of the three hundred and eighty-seven shocks is also given. Some of the results are worth noting. As regards geographical distribution, it is remarkable that only two out of the three hundred and eighty-seven shocks appear to have extended to the west of the range of mountains running up the western side of the island of Nippon, being apparently stopped by that barrier, while about eighty-four per cent seem to have originated either out under the ocean or very near it on the eastern side of the islands. Commenting on this, Professor Milne says, —

"The district which is most shaken is the flat alluvial plain of Musashi following the line of the river Tonegawa. . . . This area forms one of the flattest parts of Japan. The large number of earthquakes which have been felt on the low ground, and the comparatively small number which have been felt in the mountains, is certainly remarkable.

"It must also be observed, that, in the immediate vicinity of active or extremely recent volcanoes, the seismic activity has been small. . . . It may also be remarked that the side of Japan on which earthquakes are the most frequent is the side which slopes down steeply beneath an ocean which at a hundred and twenty miles from the coast has a depth of about two thousand fathoms, whilst on the opposite side of the country, at the same distance from the shore, the depth is only about a hundred and forty fathoms. Another point not to be overlooked is the fact that the district where earthquakes are the most numerous is one where there is abundant evidence of a recent and rapid elevation.

"In all these respects the seismic regions of Japan hold a close relationship to similar regions in South America, where we have earthquakes originating beneath a deep ocean at the foot of a steep slope on the upper parts of which there are numerous volcanic vents, whilst, on the side of this ridge opposite the ocean, earthquakes are rare. With regard to the Musashi area, it may also be remarked that sediments brought down by numerous rivers from the higher parts of the country are accumulating on it at a very rapid rate."

The distribution of the three hundred and eighty-seven earthquakes for the four quarters of the years was as follows, — January - March, 195; April - June, 70; July - September, 39; October - December, 83, — thus confirming the greatest activity in the coldest, and least in the hottest, months of the year, which had been shown before for the Tokio district alone for a long period of years.

With respect to the measurement of the motion of the ground, most of the facts deduced by Professor Milne are substantially the same as those summarized by Professor Ewing in his memoir referred to above. The following, however, which is partly, at least, new, deserves quotation here: —

"Inasmuch as it will be observed that different instruments give different results for the same earthquake, in order that the reader may not regard such diagrams as conflicting, the following results, which have been obtained from the earthquakes here referred to, and which have been confirmed by many observations made subsequently, may be enumerated:

"1. An ordinary earthquake, although having a general direction of propagation, has at a given point many directions of vibration. If there is a decided shock in a disturbance, this particular movement may be indicated in the same manner at adjacent stations.

"2. The amplitude of motion as observed at two adjacent stations, even if only a few hundred feet apart, may be extremely different.

"3. The period of motion may vary like the amplitude, the instruments being in all cases as similar as it is possible to construct them.

"At present I am carrying on observations by means of three similar instruments placed at the corners of a triangle the sides of which are about eight hundred feet in length. When these instruments are side by side, they practically give *similar* diagrams. At their present positions, they always give *different* diagrams. If these instruments were in the hands of distinct observers, each of these observers would give a totally different account of the same earthquake. Judging from the quick period and large amplitude of motion always observed at one particular corner of my triangle, I can say with confidence that at this corner there might be sufficient motion to shatter a building, whilst at the other corners similar buildings would not be damaged."

He does not state whether there is any difference in elevation or in character of soil at the corners of this triangle; but, if there is none, then this observed difference of motion is highly interesting and important, and should be tested and verified in every possible way by interchange of instruments, resetting of supports, etc., in order to be sure in every way that there is no local peculiarity of instrument or method of attachment to the soil. Doubtless this will have been fully attended to in Professor Milne's continuation of these interesting experiments.

H. M. PAUL.

A RECENT DISCUSSION OF THE AXIOMS OF MECHANICS.

THE logic of the physical sciences will always remain a fascinating field for the philosophic inquirer, and doubtless also for the special student of those sciences. The recent efforts towards a 'reform in logic' in Germany have not left this field untouched; and one of the first in importance, among the books that bear on the general topic, is the work whose title is given below. The author has qualified himself for the task by a lengthy study of the history of the development of his science, and he has the power to suggest much more than he directly says. In short, we have here a man who combines definiteness with depth of thought; and his book, whether useful or not to the specialists in mechanics, is surely very suggestive to the student of logic.

The author represents in his way the new empiricism of Germany, — a doctrine that has grown up out of a study of Kant and the English philosophy combined, and that as certainly points back again into the realm of specially philosophic discussion as it appears anxious to be forever beyond that realm. This new empiricism is much more suggestive than the older empiricism of J. S. Mill. He had founded all inductive interpretation of nature on the causal principle, and the causal principle itself again on an inductive interpretation of nature. The new empiricism escapes from this circle by assuming a relatively *a priori* principle in all induction, but seeks to remain empiricism still by making this principle no abstract axiom, but a sort of ultimate form or tendency of intelligence, viz., the tendency *to conceive of the facts of experience in the most economical way*. This interest in economy of thought shall, in the new empiricism, take the place of the old axiom of causality, and, in fact, of all the mysterious axioms of past logicians. This tendency to economy is to be the true *a priori* that Kant sought. It is to give us no knowledge transcending experience, but only a necessary presupposition concerning experience. What for bare experience would seem a confused mass, becomes for the scientific thinker, by virtue of this tendency to economy, a world of law. All the laws are indeed statements of empirical fact; but the statements never could assume this form save by virtue of the effort to economize thought.

Such is the general statement of the new empiricism. Our author, for the most part, confines his use of it to his special task, and lets general philosophy as much as possible alone. Yet he cannot but constantly suggest to the reader the philosophic problems peculiar to his method. For the rest, he lays claim in the preface to considerable relative originality in the development of his own doctrine. Before Kirchhoff and Helmholtz applied to mechanical science the general theories of the new empiricism, Mach had outlined his views in a published essay. He is thus entitled to individual credit, and open to separate criticism.

Applied to mechanical science, the new empiricism, as our author and Kirchhoff have expressed it, takes the form of declaring the purpose of mechanics to be, "the simplest possible description of the motions that are in the world." Thus at a stroke the science is to be freed from all mysterious elements. Those old ideas of force, of inertia, and the rest, are to be defined afresh in such a way as to conform to this logical theory. The science is to have its two perfectly plain bases; viz., experience of motion, of velocity, of direction, etc., and the effort to think this experience with the least effort and the greatest unity.

The historical form that Mach gives to his doctrine makes it especially attractive and enlightening; and we hope for much good effect from this element in the book. Mechanical science, as Mach frequently repeats, had its origin very plainly in the need of men whose handiwork, owing to its technical complexity, was difficult to describe to those new in the craft. The learner must be enabled to see the permanent elements of the experience of his craft beneath, and in all their endlessly various applications; he must be brought to an 'übersichtliche erfassung der thatsachen:' hence the need of quite general and simple descriptions, applying to fundamentally important facts. Economy of description thus from the first becomes the artistic principle, as it were, of this technical instruction.

If this is the origin and general method of the science in its embryonic stage, the origin

Die mechanik in ihrer entwickelung historisch-kritisch dargestellt. Von E. MACH, professor an der Universität zu Prag. Leipzig, *Brockhaus*, 1883. 10+483 p., illustr. 8°.

of the use of axioms appears, according to our author, in the fact that the learner, from long habit (not, as Mach thinks, from any *a priori* insight), has come to expect instinctively, and so to conceive very economically, certain simple sequences of facts. Purely for economic reasons, and not on philosophic grounds, nor for that matter with any philosophic justification, the teacher is disposed to seize upon these elementary facts as the constituents into which more complex facts can be analyzed, and by which these cases can be easily described. These simpler sequences are chosen simply because the learner already knows of them, and can more readily grasp them. When one calls them *a priori*, one forgets how easily a puzzling question can confuse us about their meaning, and even about their truth. Their self-evidence is the self-evidence of instinct, and they are in no philosophical sense *a priori*.

After the foregoing summary, we may fairly assert that in one respect, at any rate, Mach's method is praiseworthy; and that is, in its tendency to get rid of the mysterious element of his science. Whatever one may hold about the *a priori* in general, there is no doubt that we have had enough and too much of the purely mystical *a priori*. If there is any fundamental rational truth at the bottom of science, if science is more than a mere aggregation of facts, this rational basis, when we come to state it, must be as frank and honest and manly a principle as the most commonplace adherent of the empirical philosophy could desire. The old-fashioned *a priori*, in science, in morals, in religion, used to be represented as an arrogant and intolerant thing, mysterious in its manner of speech, violent and dogmatic in its defence of its own claims. The English empiricists used to hate this aristocratic *a priori*, and they shrewdly suspected it to be a humbug. What they gave us in its place, however, was a vague and unphilosophic doctrine of science, that you could only seem to understand, so long as you did not examine into its meaning.

Mach's view avoids the mystery of the old *a priori*. He leaves us still the mystery of the correspondence of external nature to our fundamental interests in the simplicity of its phenomena. Yet this mystery has the look of the genuine philosophic problem. The new empiricism is not and can not be final; but it promises to prove an excellent beginning, and one can at least commend it to those instructors in elementary mechanics who still puzzle their pupils with their use of the old-fashioned, mystical *a priori*. Mach's fundamental principle of the economy of thought is one that any intelligent pupil, with a few empirical facts before him, could be got to understand. But, as many not extraordinarily stupid pupils have so often felt, the mysterious way in which such axioms as the 'principle of sufficient reason' used to appear, aimlessly wandering to and fro in the text-books, could not but perplex, without in any wise helping, the young mind. That even to-day, when the empirical methods in elementary mechanics are so well developed and so generally used, the 'principle of sufficient reason' is occasionally called in to help teachers and text-books out of difficult places, — this fact is surely a 'sufficient reason' in itself for a careful study of such books as Mach's. There are many teachers of elementary mechanics to-day, who, while abhorring metaphysics, and constantly glorifying experience, never know or can tell just what ought to be done with that 'principle of sufficient reason,' which, however, as it used to be applied when it held sway in elementary mechanics, was the most miserably 'metaphysical' of all confused statements. The most ardent believer in the rational *a priori* must therefore delight to find, in such a book as Mach's, the foundation laid for future philosophic inquiry in the clear and sensible empiricism of the author, tentative and transient though this doctrine itself may prove. Only when the vague and mystical have been banished from the mere terms and axioms of the science, can a philosophic student hope successfully to grapple with the question, "How is empirical science, with certain and fixed results, possible at all?" Every one is therefore interested in such undertakings as our author's, whether one is student of mechanics or of logic, or teacher of either; for every one is interested in plain and frank thinking, free from appeals to merely mystical principles.

In concluding, we must call special attention to our author's discussion of the question of absolute and relative motion, which he seems to us to have treated with marvellous skill; and thus we are obliged unwillingly to leave a book that is so full of learning and suggestion.

THE SNAKE-DANCE OF THE MOQUIS.

CAPT. BOURKE has given us here a most interesting account of his experience among the

The snake-dance of the Moquis of Arizona; being a narrative of a journey from Sante Fé, New Mexico, to the villages of the Moqui Indians of Arizona, with a description of the manners and customs of this peculiar people, and especially of the revolting religious rite, the snake-dance. By JOHN G. BOURKE, captain third U.S. cavalry. New York, *Charles Scribner's sons*, 1884. 371 p., 31 pl. 8°.

Moqui Indians. It is a fascinating book, both to the scientific and general reader. With a graphic pen he carries you with him on a long trip replete with thrilling incidents, over regions seldom visited. The book savors rather of a conglomeration of detached notes, than a compilation. Perhaps too much was attempted in trying to give a popular account of his trip, and yet preserve the flavor of the note-book written on the spot, which is so valuable for scientific purposes. He seems also to have fallen into the mistake of supposing his readers to be cut off from books, as he unfortunately was, and has filled the larger part of three chapters (pp. 196–225) with quotations which it would have been sufficient to give by reference. The minuteness of detail with which he describes every circumstance seems unnecessary while his travels were in not unknown regions; but they become invaluable when he describes the snake-dance, and his visits to the various Moqui villages. The book consists of an account of a dance in one of the pueblos on the Rio Grande, which is curious from its mixture of old heathen ceremonies with the Roman forms introduced by the Spanish priests; then of his trip through a corner of the Navajo reservation to the Moqui village of Hualpi (pronounced Wolpi), where the snake-dance was witnessed; and then of visits to the other pueblos of the Moquis. These Moquis occupy several isolated *mesas* in north-eastern Arizona, and are by far the most primitive of all the Pueblo tribes. They were not affected even by the Spanish civilization, as were all the other tribes, including the closely related Zuñis, and are to-day almost what they were four hundred or more years ago. Their life, habits, costumes, and industries are described with an accuracy and minuteness which renders the book invaluable to the ethnologist, and yet so entertainingly that no one can fail to be interested. The snake-dance seems to be the last remnant of what was once an almost universal worship among the tribes of North America. Owing to fortunate circumstances and his own coolness and untiring perseverance, Capt. Bourke was able to see even the secret ceremonies of this dance, which no white man has seen before, or will be likely to see so thoroughly again.

The plates accompanying the work are admirable reproductions of the artist's paintings. It is sufficient to say that the paintings are by Moran, and are accurate in color and drawing, as well as spirited and realistic, — a quality generally absent in illustrations of Indians. They alone are worth the cost of the book.

NOTES AND NEWS.

THE meteorological observatory at Tokio has recorded 546 Japanese earthquakes in the ten years ending Dec. 10, 1884. Of these, 334 (or fifty-six per cent) have occurred during the six colder months, and 212 (or thirty-five per cent) during the six warmer months, of the year. Professor Milne's compilation of 387 earthquakes observed in northern Japan in the two years ending October, 1883, however, shows a still greater proportion for the winter months; the percentages being seventy-two for the months from October to March inclusive, and twenty-eight from April to September.

— Prof. J. P. O'Reilly has recently published in the Transactions of the Royal Irish academy a map of Great Britain and Ireland in which he has attempted to graphically represent the earthquakes of the United Kingdom relative to their frequency. It would appear that Ireland has been less subject to shocks than Great Britain; that the points of more frequent action in Ireland lie near or on the coast; and that the south coast of England presents a number of points of activity situated approximately on the same line, in all probability connected with a system of jointing corresponding to the general direction of the coast.

— Dr. M. Eschenhagen writes to *Nature* that the earthquake shock of Dec. 25 last was registered by the magnetograph at the imperial marine observatory at Wilhelmshaven; the Lloyd's magnetic balance, the instrument for vertical intensity, being set in oscillation first at 9.52 P.M., local time.

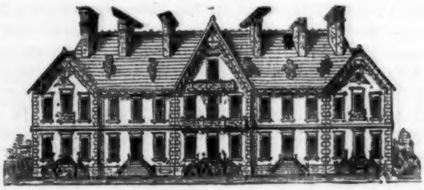
— The earthquake wave of Jan. 22 last in England appeared to the vicar of Bampton to pass directly under his house. A letter from Mr. Edward Parfitt in *Nature* states that it occurred at 8.42 P.M. In the drawing-room at the vicarage it appeared as if a heavy traction-engine was passing close to the window: the window faces eastward. In the kitchen the servants were greatly alarmed by a rumbling noise and a shaking under the floor. Some of the vicar's neighbors say they heard a report; and houses with cellars under them, and higher, felt the shaking more. Some persons who were up stairs, thinking that it was some explosion, rushed down stairs and out of doors. The effects were also felt at Shillingford, two miles distant; and also at Combehead, one and a half miles distant. The porters at the station describe it as like a heavily-laden mineral-train passing. The only damage done at Bampton was that a piece of wall was thrown down.

— It is suggested by the Seismological society of Japan that the system of telegraph-stations around Tokio and Yokohama may be utilized in warning the inhabitants of either city of the approach of an earthquake. This might be accomplished by causing such a shock, felt at any of these stations, to complete an electric circuit which could be made to fire a gun almost instantaneously. The inhabitants would receive from two to six minutes' warning, which would give them sufficient time to extinguish their fires,

remove their most valuable goods, and reach open ground before the arrival of the shock.

— A recent issue of *La Nature* (Jan. 3, 1885), describing an earthquake which occurred in the valley of the Durance in south-eastern France at eleven P.M. on Nov. 27, 1884, notices and illustrates this curious phenomenon.

"The roof of a chalet at Sainte Catherine was suddenly transformed into a vibrating plate, and was broken in several equi-distant places. These injuries could not be attributed to the fall of bricks from the chimneys. The slates were dislodged, and not broken; and the exposed portions of the wood-work, far from being in the vertical line from the chimneys, were found at precisely equal distances from each other. Moreover, the outside chimneys have not lost a single brick, and yet the roof is as much injured in these two places as in the others."



CHALET AT ST. CATHERINE, SHOWING ROOF BROKEN BY EARTHQUAKE.

The chalet referred to is represented in the accompanying illustration as a brick building with sloping roof, divided by a central projecting gable, and surmounted by a row of six chimneys, each capped with a large flat stone. The end chimneys are uninjured; but the capstones of the four middle chimneys have been more or less moved from their places, and one has disappeared entirely, making a hole in the roof by its fall. Besides this hole, which is at the upper side, and close to the chimney from which the stone fell, there are upon the lower part of the roof five spots where the slates are removed, as if these had been the ventral segments of a stationary vibration set up in the roof; its normal period of vibration, when thus divided, happening to agree with the period of some of the vibrations caused by the earthquake.

— *Nature* states that fresh shocks of earthquake occurred on Jan. 27 and 28 in the hot-spring district of southern Styria. A severe and prolonged shock was felt at Valparaiso at four o'clock on the morning of the 27th; and on the 31st a shock destroyed eight Arab houses in Algiers: this last was also felt at Setif.

— The Rev. Mr. Doane writes from Ponape, Caroline Islands, in October, 1884, of the arrival, in large quantities, of pumice-drift ejected by Krakatoa a year before. It is a boon to the natives, who crush the pumice, and fertilize the arid coral sand of the low atolls with it.

— The telephone is to be introduced into the Kongo region by the International African association.

— Capt. Scopinich, of the Austrian brig Mater, reports having experienced terrific earthquake shocks on the 22d of December, 1884, in the vicinity of the Azores. The weather was very fine at the time, with a light easterly breeze.

— The committee on thought-transference, of the American society for psychical research, has issued a circular requesting the co-operation of all persons interested in investigating the subject; that is, in ascertaining whether "a vivid impression or a distinct idea in one mind can be communicated to another mind without the intervening help of the recognized organs of sensation." It is the intention of the committee to make experiments upon persons supposed to have the faculty of 'mind-reading.' The committee also desires to collect statistics as to experiments of uniform character, but made by a large number of observers, similar to those made by Charles Richet, and described in *Science* (vol. v. p. 132). Precise directions for making each series of experiments are appended to this circular. In entering on this inquiry, the committee wish to be understood as expressing no opinion, on one side or the other, in regard to the reality of the supposed thought-transference. They simply seek to institute a thorough and entirely unbiassed investigation of the class of phenomena known under the name of 'mind-reading,' in the hope of taking at least a distinct step towards the true explanation of those phenomena, whatever that explanation may be. All inquiries and communications should be addressed to the secretary, Mr. N. D. C. Hodges, 19 Brattle Street, Cambridge, Mass.

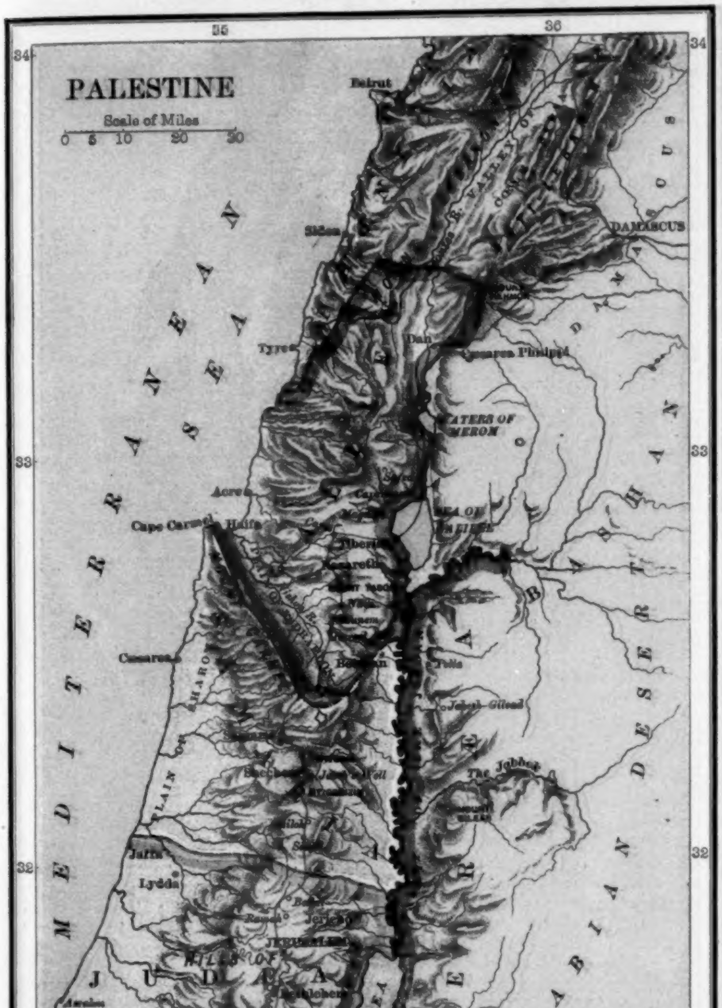
— In their report on underground circuits, the committee of examiners of the Philadelphia electrical exhibition call attention to the desirability, in the present tentative condition of our knowledge of underground wires, of all conduits built for such purpose being so constructed as to be easily adaptable to a number of systems. In regard to conducting electric currents underground, the committee records its opinion that there can be no doubt of the ultimate feasibility of the scheme.

— The first number of *Petermann's mittheilungen* for this year appears under the editorship of Dr. A. Supan, well known for his writings on matters of physical geography. The articles are chiefly concerned with explorations and general descriptions; but continued attention is promised to physical geography as well, and the current bibliography that closes the number includes mention and abstract of several papers of this character. Most of these abstracts are by Dr. Supan himself, while the monthly review of exploration is by Dr. Wichmann.

— The foundation of a chair of hygiene at the University of Berlin is an accomplished fact. Besides the professorship, a laboratory for hygienic research is to be instituted.

— The Italian explorer, Signor Franzoi, intends to undertake another six or seven years' expedition into central Africa.

Specimen of Engraving and Printing, by STRUTHERS, SERVOSS & CO., 32 & 34 Frankfort St., New York. Printed from Relief-plates—six impressions.



The Red line from Jerusalem North marks the route followed in the present journey. The line from Gaza shows the approach from the South in coming up from the Desert.

[From "Among the Holy Hills," by the Rev. H. M. Fields, D.D. By permission Messrs. Chas. Scribner's Sons, New York, Publishers.]